CLAIMS

What is claimed is:

1. A method of forming a semiconductor integrated circuit dielectric composite film, the method comprising:

forming a dielectric matrix film on a semiconductor wafer; and

distributing a reinforcing material comprising one of fibers and nanostructure whiskers throughout the dielectric matrix film to form the dielectric composite film.

2. The method of forming a semiconductor integrated circuit dielectric composite film as recited in claim 1 wherein the reinforcing material comprises nanostructure whiskers.

3. The method of forming a semiconductor integrated circuit dielectric composite film as recited in claim 1 wherein the dielectric matrix film is selected from the group consisting of SiO_2 and low-k dielectric layers.

4. The method of forming a semiconductor integrated circuit dielectric composite film as recited in claim 1 wherein the reinforcing material is distributed simultaneously with the formation of the low-k dielectric matrix film using a CVD method.

5. The method of forming a semiconductor integrated circuit dielectric composite film as recited in claim 1 wherein the reinforcing material comprises an insulating ceramic material.

6. The method of forming a semiconductor integrated circuit dielectric composite film as recited in claim 2 wherein the whiskers are rod-shaped and have a length in the range from 5 to 20 nm.

7. The method of forming a semiconductor integrated circuit dielectric composite film as recited in claim 2 wherein the whiskers have aspect ratios in the range of 5:1 to 300:1.

8. The method of forming a semiconductor integrated circuit dielectric composite film as recited in claim 2 wherein the whiskers are randomly oriented.

9. The method of forming a semiconductor integrated circuit dielectric composite film as recited in claim 2 wherein the volume of the whiskers in relation to the volume of the matrix material lies in the range from 0.1 to 10 %.

10. The method of forming a semiconductor integrated circuit dielectric composite film as recited in claim 2 wherein the whiskers comprise one of SiC, Si_3N_4, and SiO_2, and diamond structured whiskers.

11. The method of forming a semiconductor integrated circuit dielectric composite film as recited in claim 2 wherein the reinforcement whiskers are formed in the composite layer by suspending the whiskers in a spin-on liquid.

12. The method of forming a semiconductor integrated circuit dielectric composite film as recited in claim 1 further comprising heating the dielectric matrix film to vaporize volatile components.

13. The method of forming a semiconductor integrated circuit dielectric composite film as recited in claim 1 further comprising etching the dielectric matrix film to remove a majority of the dielectric film matrix.

14. The method of forming a semiconductor integrated circuit dielectric composite film as recited in claim 2 wherein the whiskers are single crystal nano-structures.

15. The method of forming a semiconductor integrated circuit dielectric composite film as recited in claim 2 wherein the whiskers have a bipolar structure and further comprising applying a field to the dielectric composite film to orient the whiskers in a predetermined orientation.

16. The method as recited in claim 1 further comprising forming an inlaid conductive layer in the low-k composite layer.

17. The method as recited in claim 16 wherein the inlaid copper layer is a copper dual-damascene interconnect structure.

18. A dielectric composite film comprising:

a low-k dielectric matrix film; and

whisker reinforcements distributed throughout the film.

19. The dielectric composite film as recited in claim 18 wherein the whisker reinforcements are selected from the group consisting of SiC, Si_3N_4, oxides, polymers, and diamond structured materials.

20. The dielectric composite film as recited in claim 19 wherein the whisker reinforcements comprise an insulating ceramic.

21. The dielectric composite film as recited in claim 19 wherein the whiskers occupy a volume in the matrix in the range of 0.1 to 10%.